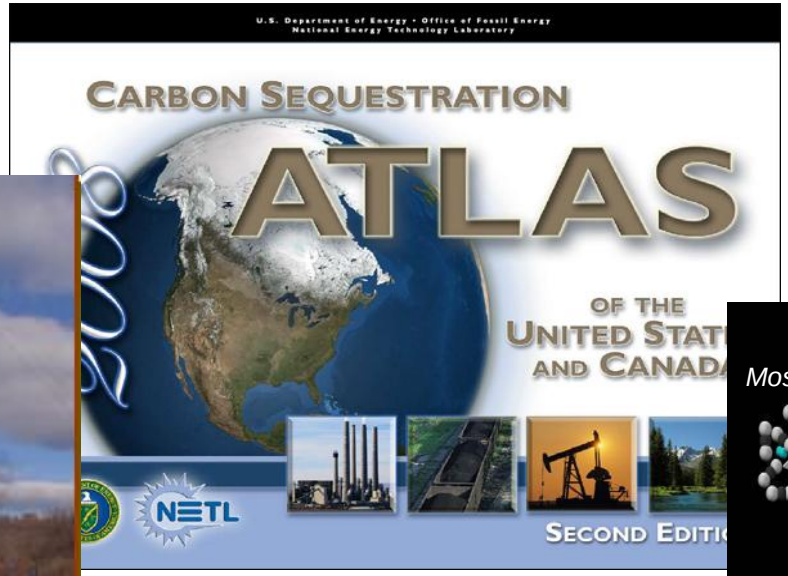
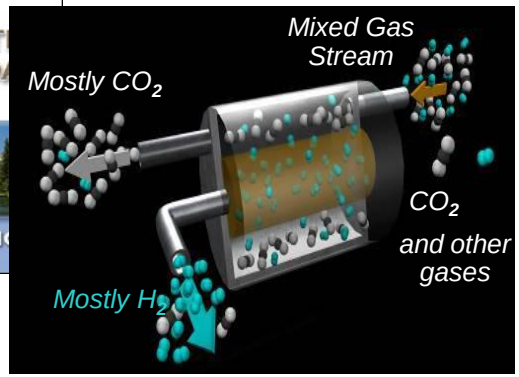




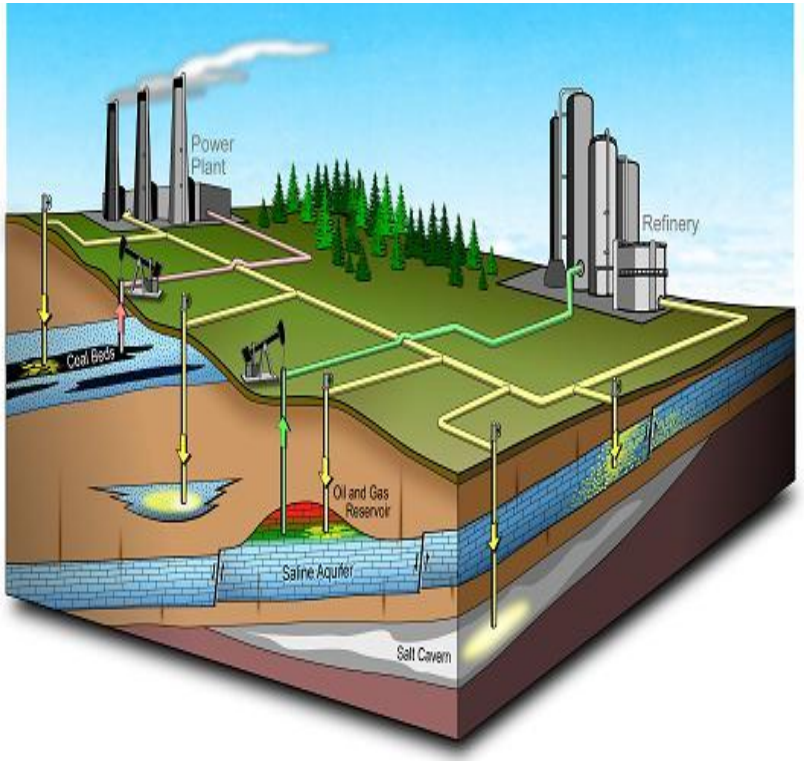
Sequestration Program Overview

John Litynski
Sequestration Division Director
Feb 3, 2010

DOE's Carbon Sequestration Program Goals

Develop Technology Options by 2020 That...

- **Deliver technologies & best practices that provide Carbon Capture and <u>Safe</u> Storage (CCSS) with:**
  - 90% CO_2 capture at source
  - 99% storage permanence
  - < 10% increase in COE
    - Pre-combustion capture (IGCC)
  - < 35% increase in COE
    - Post-combustion capture
    - Oxy-combustion

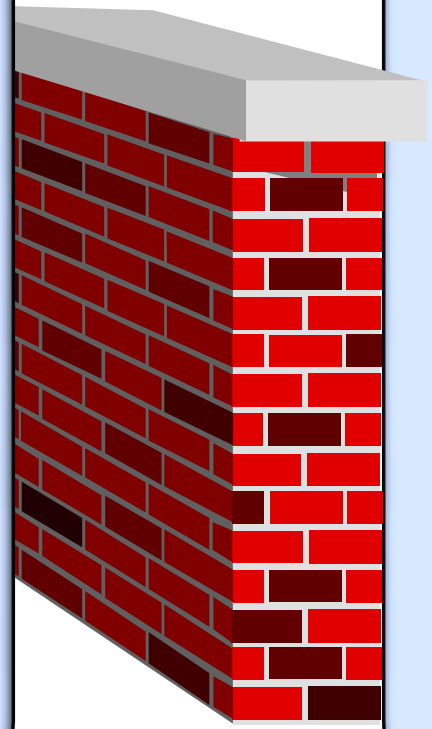


Key Challenges to Carbon Capture and Storage

Focus Infrastructure to Address Both Types of Issues

Technical Issues

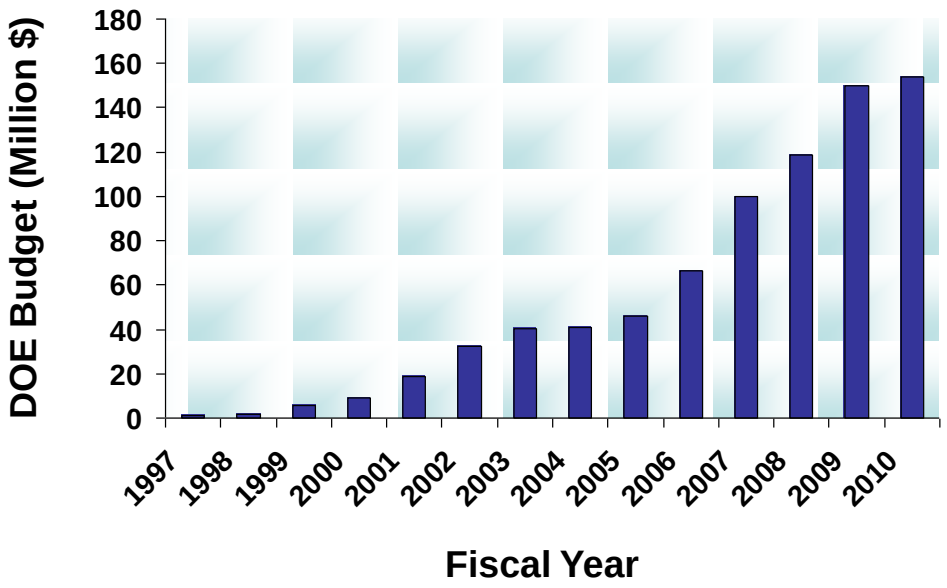
- **Capture Technology**
  - Existing Plants
  - New Plants (PC)
  - IGCC
- **Cost of CCS**
- **Storage Capacity**
- **Permanence**
- **Best Practices**
  - Storage Site Characterization
  - Monitoring/Verification
  - Site Closure
  - Etc etc …



Legal/Social Issues

- **Regulatory Framework**
  - Permitting
  - Treatment of CO_2
- **Infrastructure**
- **Human Capital**
- **Legal Framework**
  - Liability
  - Ownership
    - pore space
    - CO_2
- **Public Acceptance (NIMBY → NUMBY)**

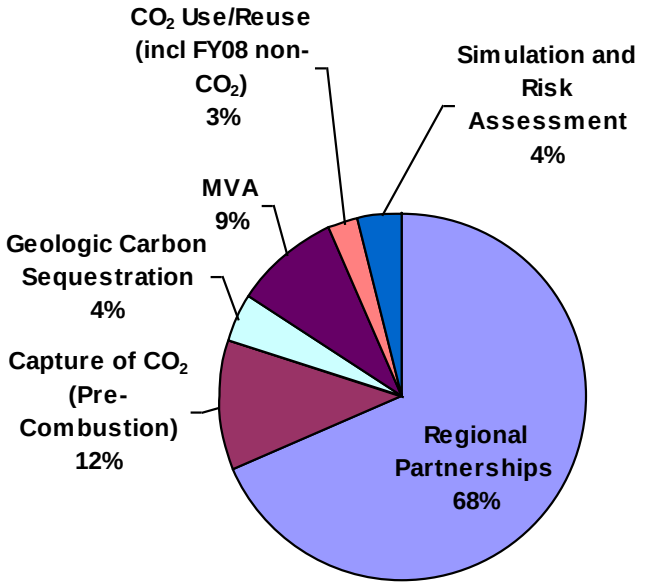
Sequestration Program Statistics FY2009



Strong industry support
~ 39% cost share on projects

Federal Investment to Date
~ $631 Million

2009 Budget Breakdown



Diverse research portfolio

80+ Active R&D Projects

61 ARRA Projects

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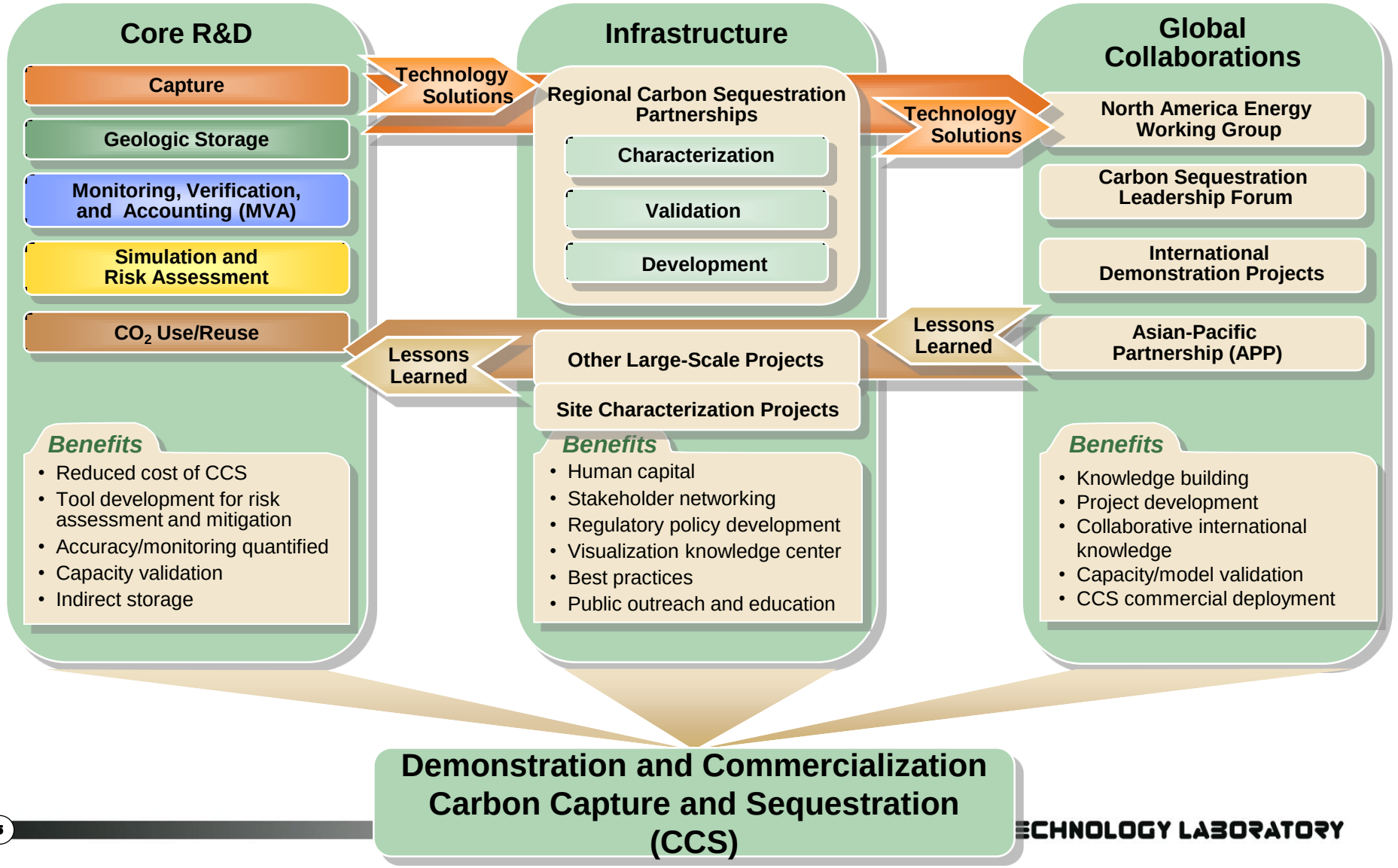
CARBON SEQUESTRATION PROGRAM



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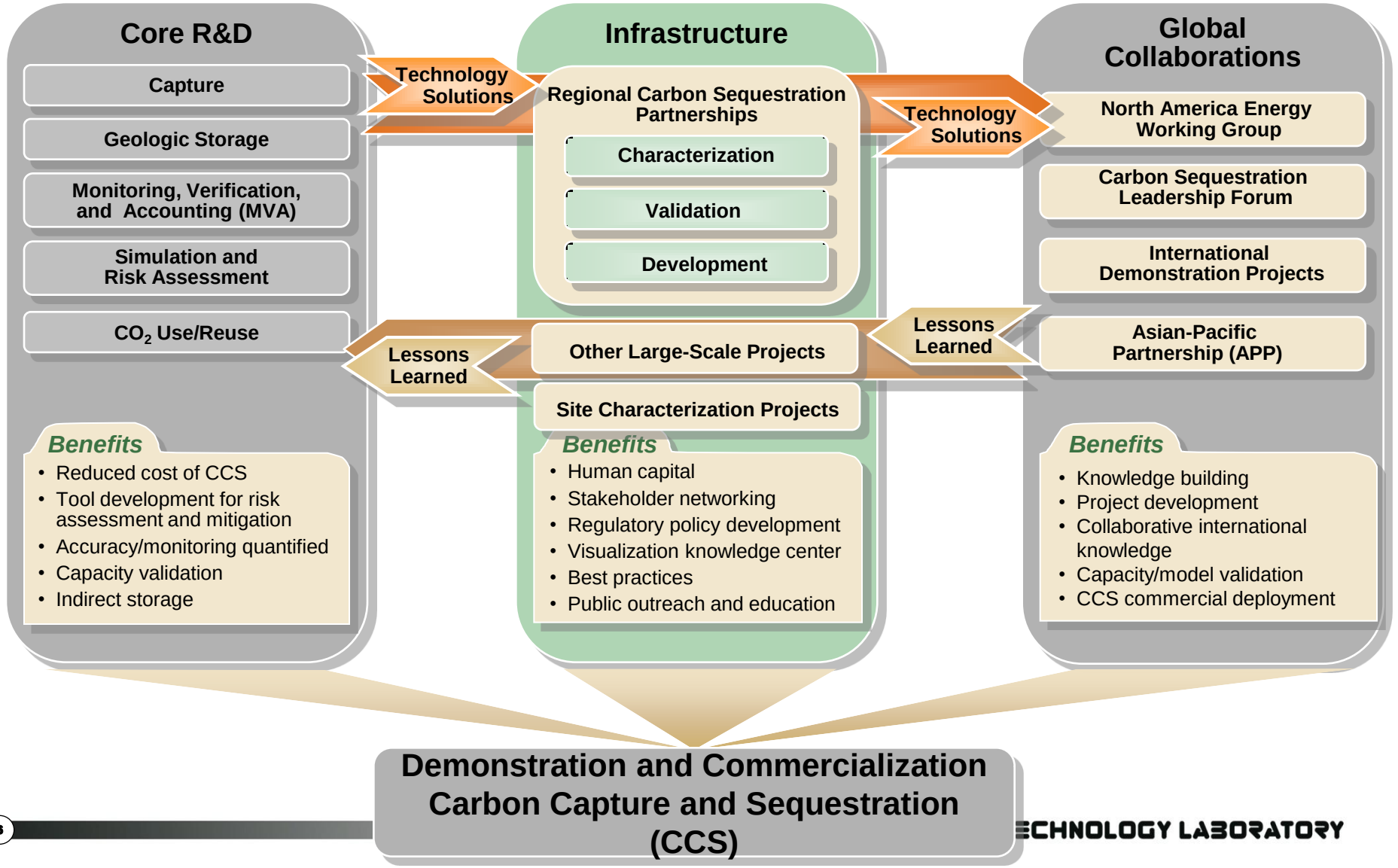
CARBON SEQUESTRATION PROGRAM



Regional Carbon Sequestration Partnerships

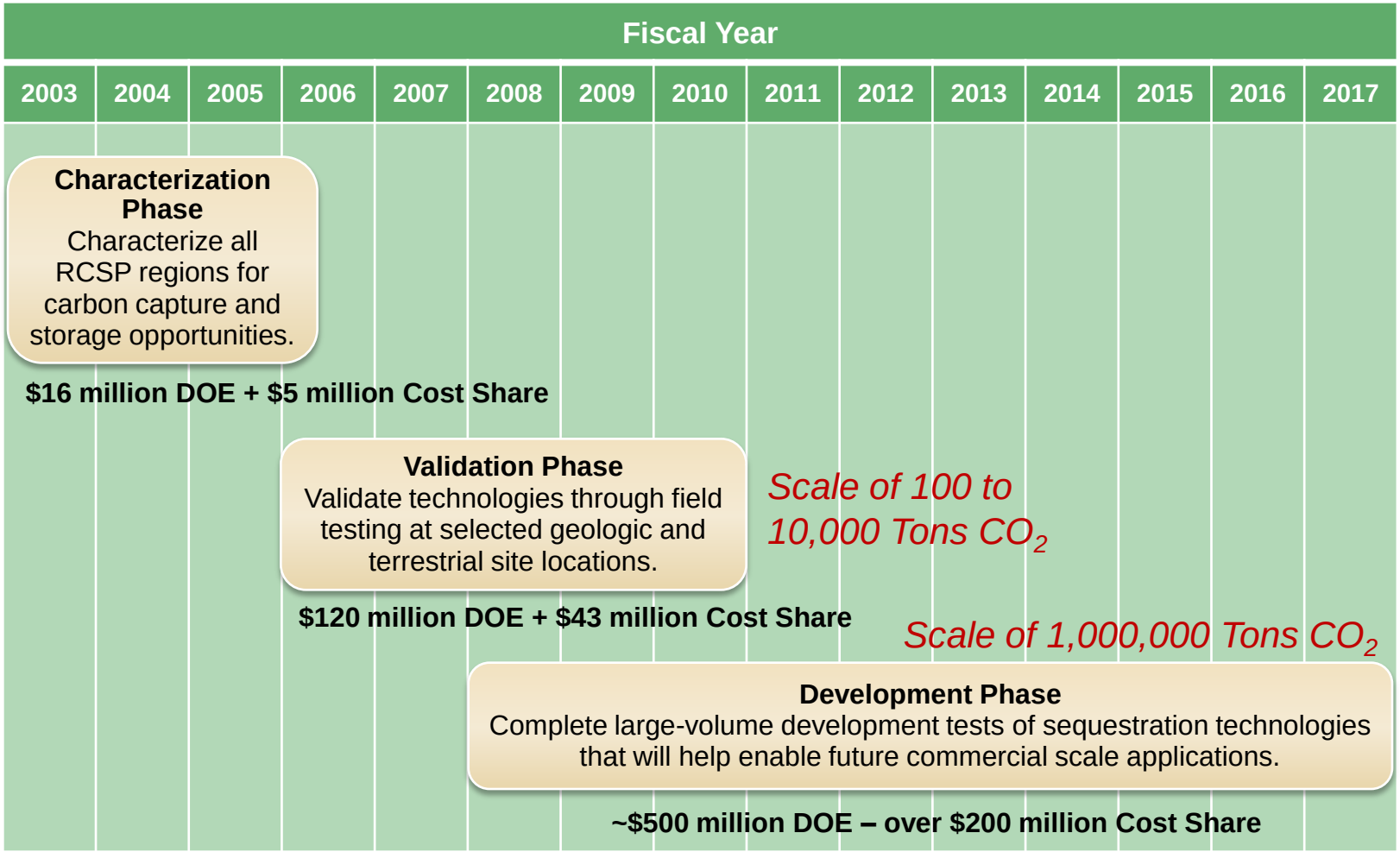
- Engage regional, state, and local governments
- Determine regional sequestration benefits
- Baseline region for sources and sinks
- Establish monitoring and verification protocols
- Address regulatory, environmental, and outreach issues
- Validate sequestration technology and infrastructure

- 7 Regional Partnerships
- 43 States, 4 Canadian Provinces
- 350+ distinct organizations

Developing the Infrastructure for Wide-Scale Deployment

Regional Carbon Sequestration Partnerships

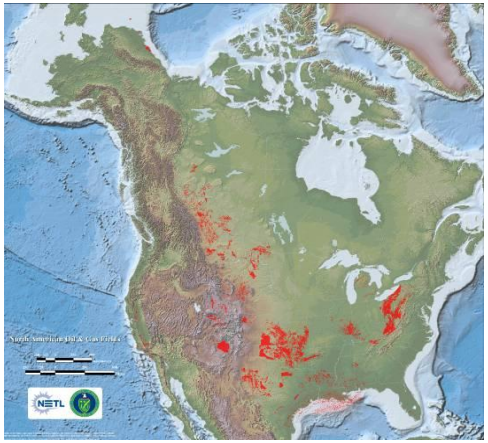
Program Phases



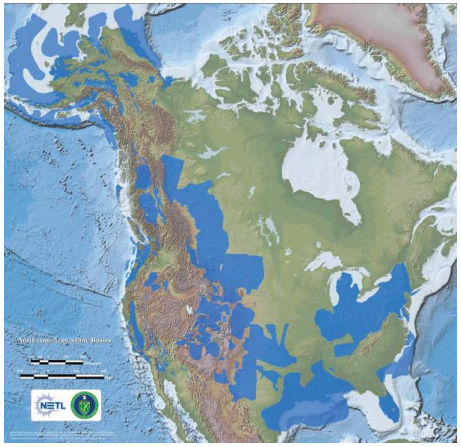
UPDATED: National Atlas Highlights (Atlas II)

Adequate Storage Projected

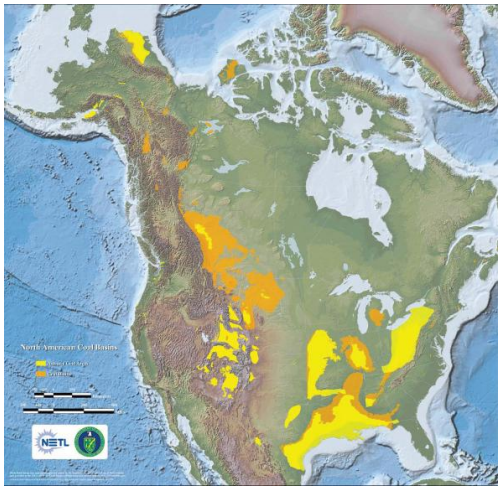
Emissions ~ 3.8 GT CO_2/yr point sources



Oil and Gas Fields



Saline Formations



Unmineable Coal Seams

North American CO_2 Storage Potential (Giga Tons)

Sink Type	Low	High
Saline Formations	3300	12,600
Unmineable Coal Seams	160	180
Oil and Gas Fields*	140	140

Conservative Resource Assessment

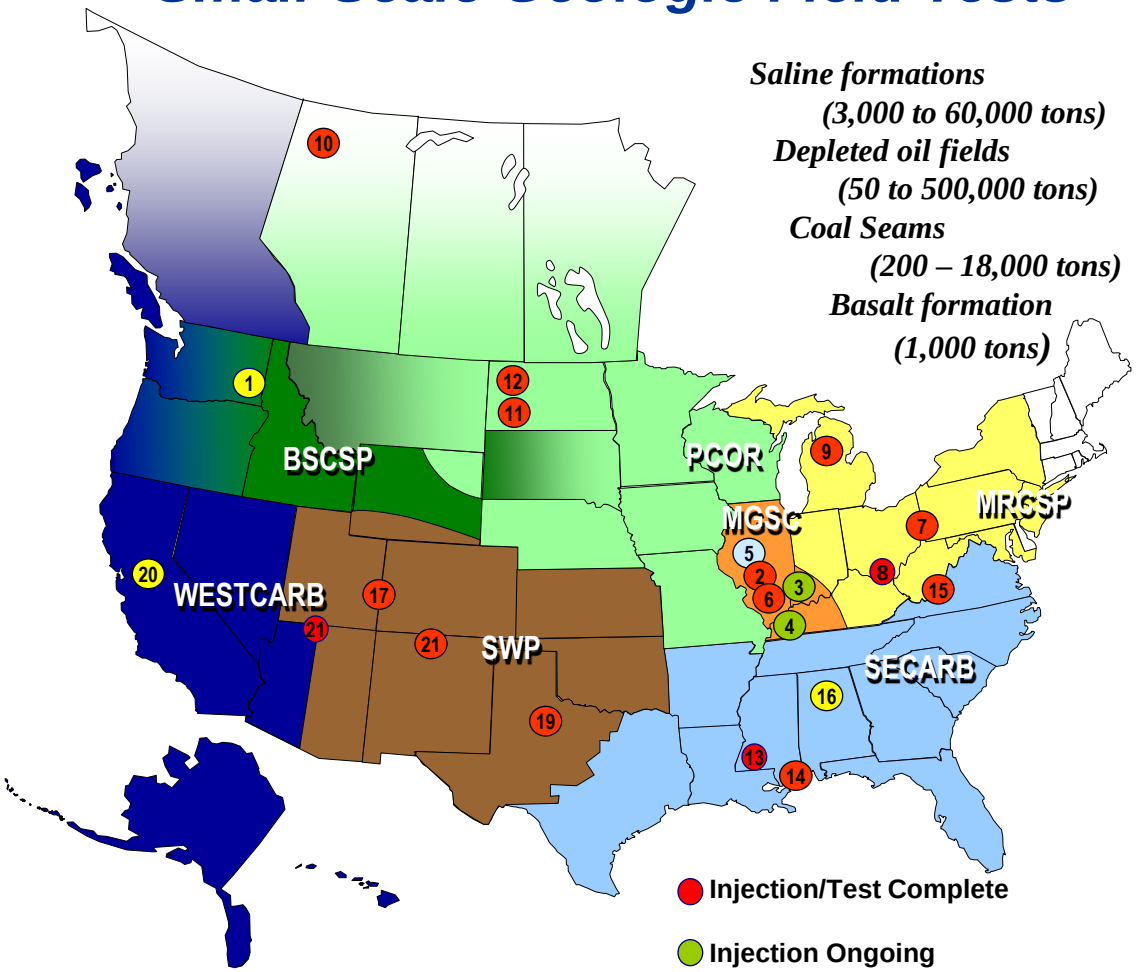
Increases from Atlas I

Hundreds of Years of Storage Potential

**** 89 billion barrels of additional oil could be recovered through CO2 EOR/Storage***

Available for download at http://www.netl.doe.gov/technologies/carbon_seq/refshelf/atlasII/atlasII.pdf

RCSP Validation Phase: *Phase II*
Small-Scale Geologic Field Tests



RCSP	Formation Type	Geologic Province
Big Sky	Saline 1	Columbia Basin
MGSC	Oil-bearing 2 3 4 Saline 5 Coal seam 6	Illinois Basin
MRCSP	Saline 7 8 9	Cincinnati Arch, Michigan Basin, Appalachian Basin
PCOR	Oil-bearing 10 11 Coal seam 12	Keg River, Duperow, Williston Basin
SECARB	Oil-bearing 13 Saline 14 Coal seam 15 16	Gulf Coast, Mississippi Salt Basin, Central Appalachian, Black Warrior Basin
SWP	Oil-bearing 17 18 Coal seam 19	Paradox Basin, Aneth Field, Permian Basin, San Juan Basin
WESTCARB	Saline 20 21	Sacramento Valley, Colorado Plateau

Completed 15 Injections

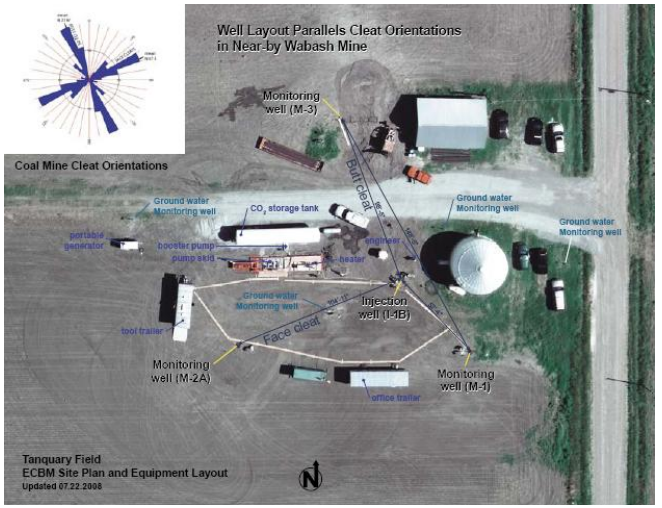
Over 1.35 M Tons injected

Data Current as of April 2009

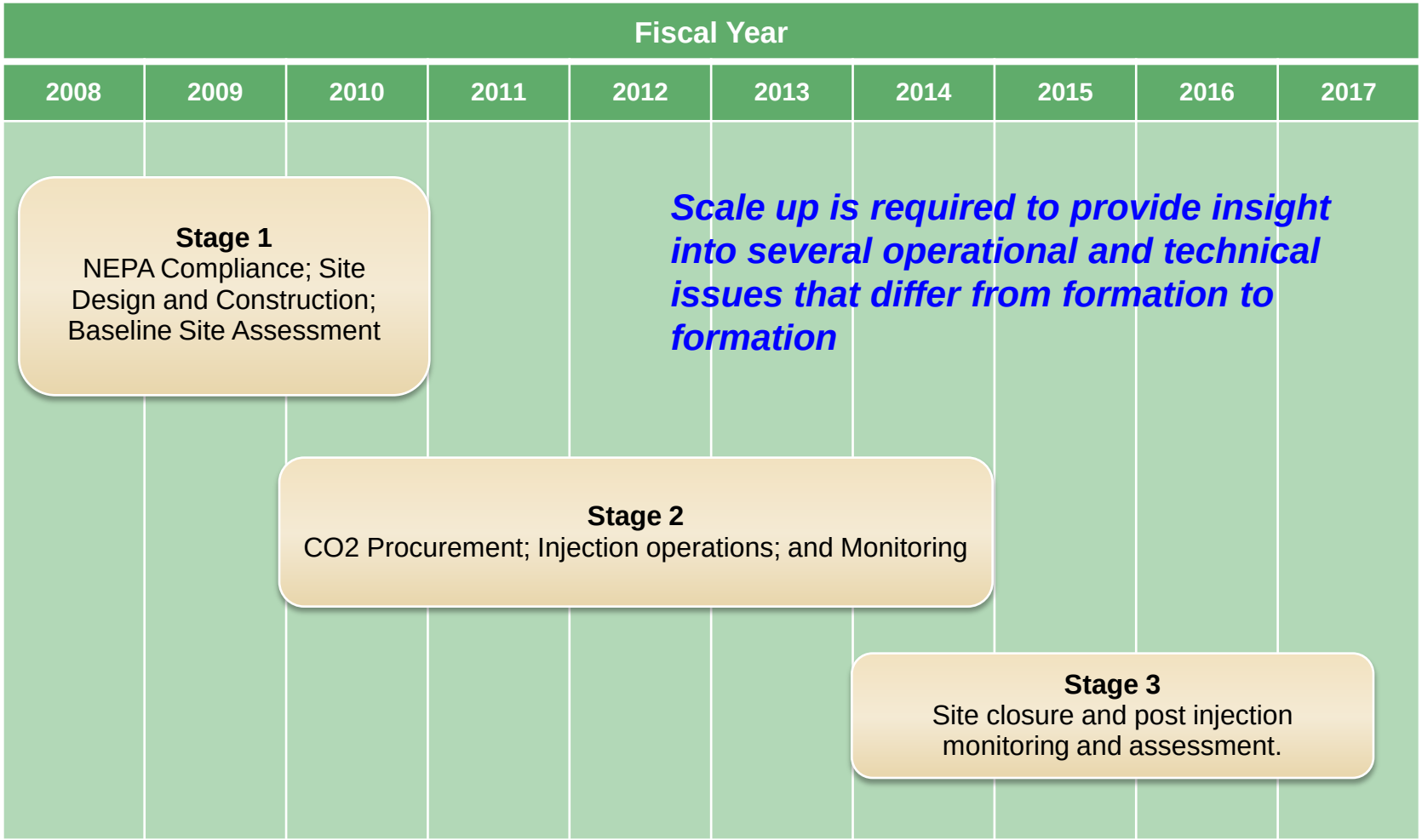
Validation Phase Project Status

Geologic Projects

- **Saline formations (3,000 to 60,000 tons)**
  - Projects in Michigan, Mississippi, Indiana, and Ohio have completed injection
- **Depleted oil fields (50 to 500,000 tons)**
  - Illinois Basin, Mississippi, Utah, Texas, Alberta, and North Dakota projects complete
  - Currently injecting in Indiana and Kentucky
- **Coal Seams (200 - 18,000 tons)**
  - Injection complete in Appalachia, New Mexico, Illinois, North Dakota
- **Basalt formation**
  - Wallula, WA – Grande Ronde Basalt
- **Remaining injection projects scheduled to begin injection by end of 2009**
- ***These injection tests lay the foundation and path for larger scale injections and ultimately integrated capture and storage tests***

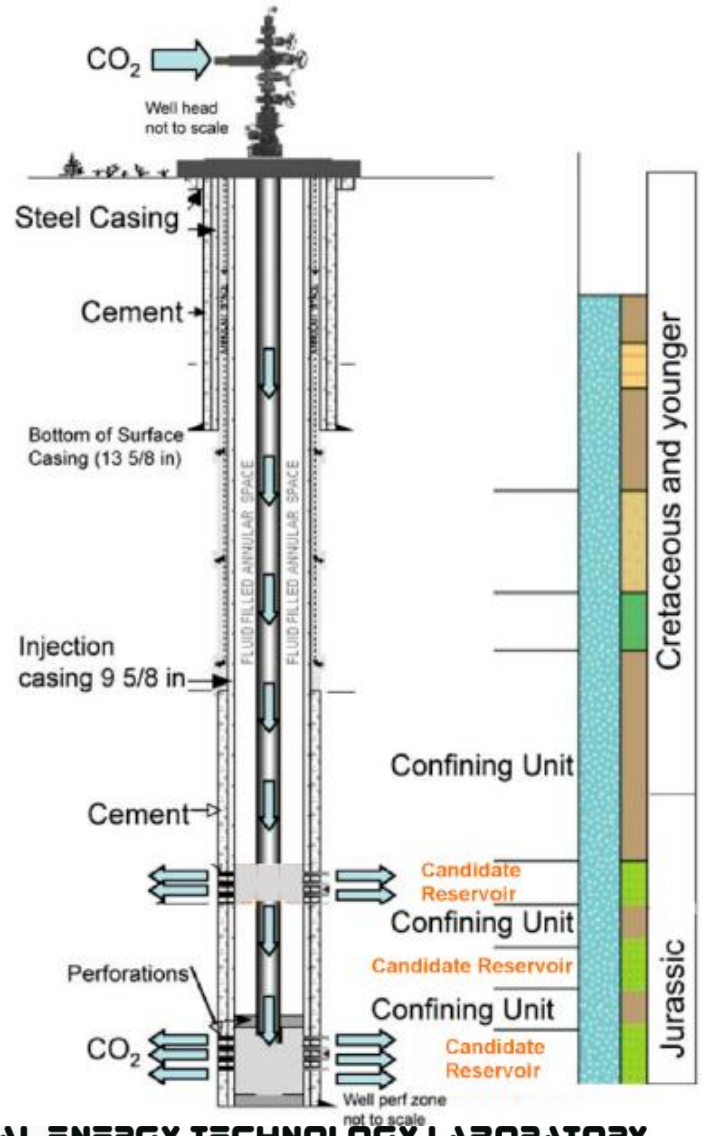


Development Phase
Scaling Up Towards Commercialization



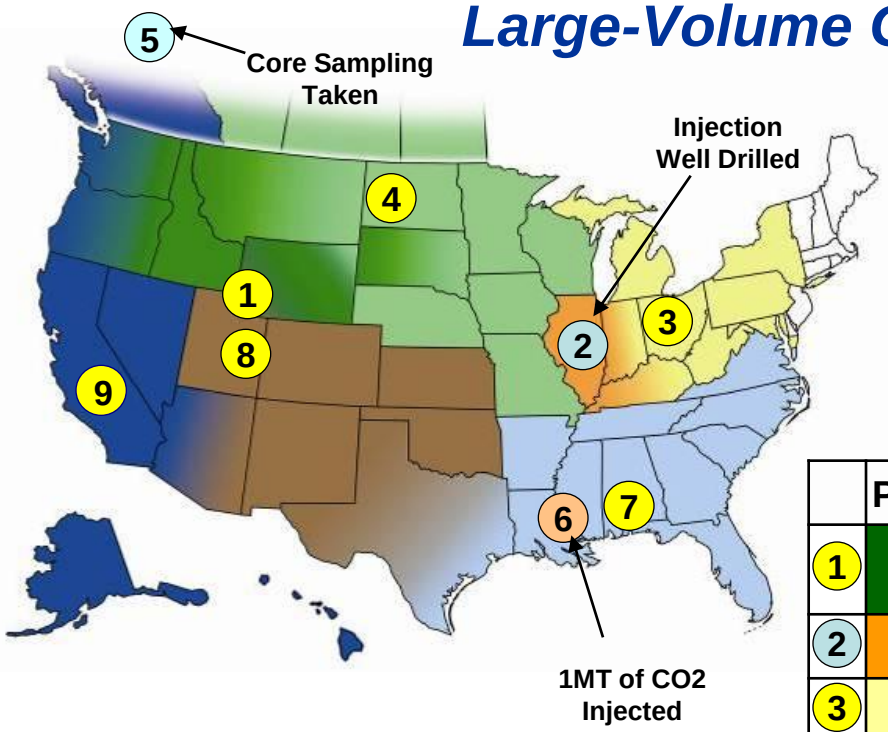
Development Phase Goals

- Assess
  - Injectivity and Capacity
  - Storage Permanence
  - Areal Extent of Plume and Leakage Pathways
- Develop
  - Risk Assessment Strategies
  - Best Practices for Industry
- Engage in Public Outreach and Education
- Support Regulatory Development



RCSP Phase III: Development

Large-Volume Geologic Field Tests



- ✓ *Nine large-volume tests*
- ✓ *Injections initiated 2009 – 2012*

	Partnership	Geologic Province	Type
1	Big Sky	Triassic Nugget Sandstone / Moxa Arch	Saline
2	MGSC	Deep Mt. Simon Sandstone	Saline
3	MRCSP	Shallow Mt. Simon Sandstone	Saline
4	PCOR	Williston Basin Carbonates	Oil Bearing
5		Devonian Age Carbonate Rock	Saline
6	SECARB	Lower Tuscaloosa Formation Massive Sand Unit	Saline
7			
8	SWP	Regional Jurassic & Older Formations	Saline
9	WESTCARB	Central Valley	Saline

- 2009 Injection Scheduled
- 2010/2011 Injection Scheduled
- 2011/2012 Injection Scheduled

Illinois Basin-Decatur Project

First UIC Class I Nonhazardous CO_2 Permit in the U.S.

Observation/sampling well to be drilled Spring 2010

3D Seismic being collected

Injection begins August 2010

MGSC

U.S. DEPARTMENT OF ENERGY

ADM

ILLINOIS

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

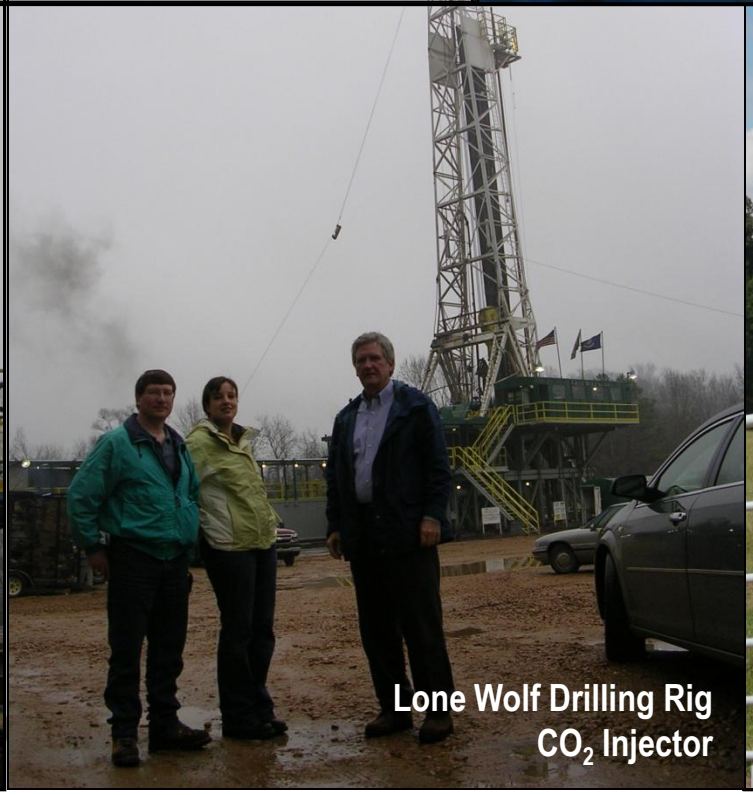
SECARB - Cranfield Unit


During Perforation of Ella G. Lees #7 Monitoring Well


Injection Well


Perforating Gun Used for Workover of Ella G. Lees #7 Monitoring Well

Workover Rig on Ella G. Lees #7 Well Phase II Monitoring Well


Lone Wolf Drilling Rig CO_2 Injector

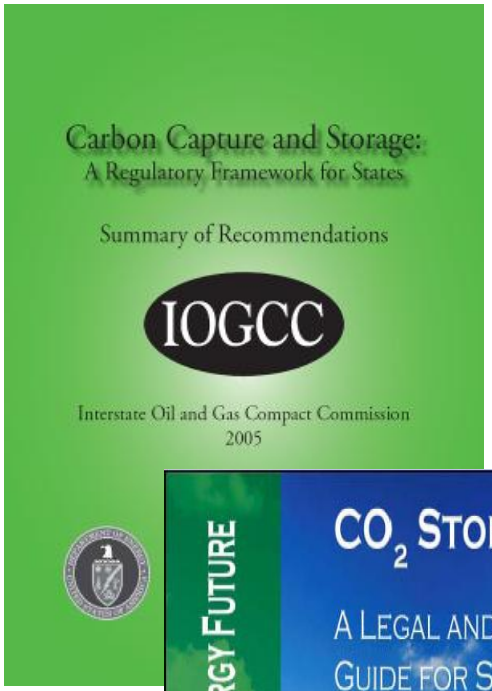

Satellite Uplink

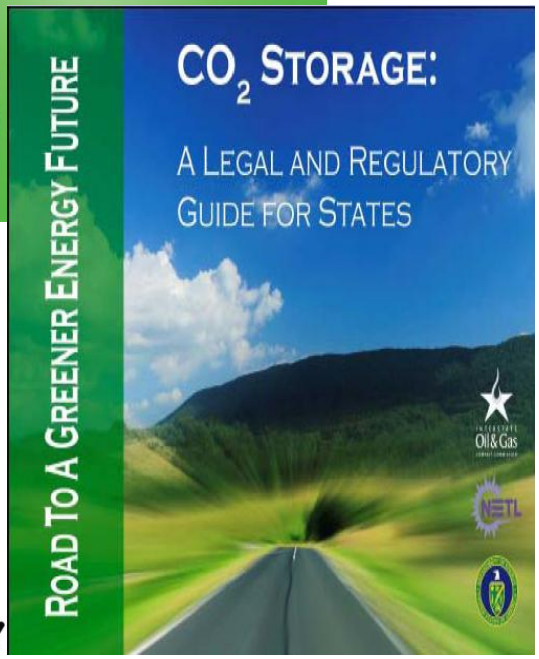
CCS Best Practice Manuals
Critical Requirement For Significant Wide Scale Deployment -*Capturing Lessons Learned*

Best Practices Manual	Version 1 (Phase II)	Version 2 (Phase III)	Final Guidelines (Post Injection)
Monitoring, Verification and Accounting	2009	2017	2020
Site Characterization	2010	2016	2020
Simulation and Risk Assessment	2010	2017	2020
Well Construction and Operations	2010	2017	2020
Regulatory Compliance	2010	2016	2020
Public Outreach and Education	2009	2016	2020
Terrestrial	2010	**2016 – Post MVA Phase III**	

Regulatory Guidelines Emerging

- **EPA & DOE Working Group**
- **EPA Underground Injection Control Program**
  - Class V guidance – March 2007
  - Proposed Class VI Rules – July 2008
  - Notice of Data Availability (NODA) – August 2009
  - Class VI Final Rule – early 2011
- **EPA Office of Air and Radiation**
  - Responsible for CO_2 emissions and accounting
- **Interstate Oil and Gas Compact Commission**
  - Regulatory Framework – 2005
  - Model Regulations – 2008
  - Regulatory Best Practices Manual – 2010
  - CO2 Pipeline efforts – started in 2009
- **Offshore sub-seabed studies initiated**

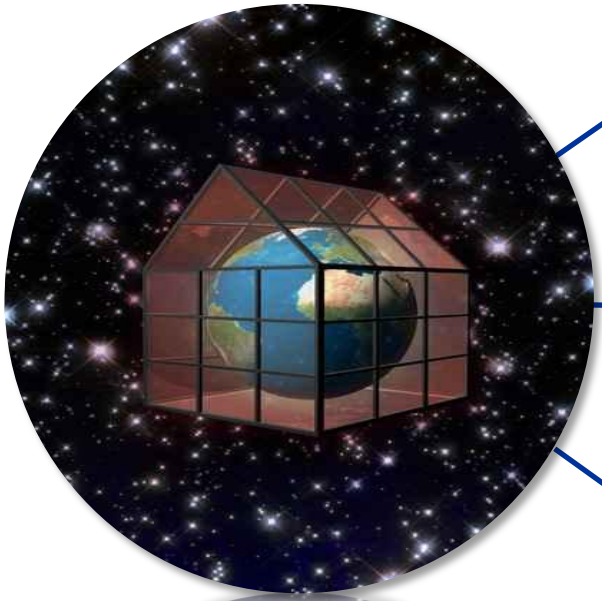




Selected DOE Participation in International CO_2 Storage Projects

Location	*Operations*	*U.S. Invol.*	*Reservoir*	*Operator /Lead*	*Int'l Recognition*
North America, Canada Saskatchewan **Weyburn-Midale**	1.8 Mt CO_2/yr commercial 2000	2000-2011	oil field carbonate EOR	Encana, Apache	IEA GHG R&D Programme, CSLF
North America, Canada, Alberta **Zama oil field**	250,000 tons CO_2, 90,000 tons H_2S demo	2005-2009	oil field carbonate EOR	Apache (Reg. Part.)	CSLF
North America, Canada, British Columbia **Fort Nelson**	> 1 Mt CO_2/yr, 1.8 Mt acid gas/yr large-scale demo	2009-2015	saline formation	Spectra Energy (Reg. Part.)	CSLF
Europe, North Sea, Norway **Sleipner**	1 Mt CO_2/yr commercial 1996	2002-2011	marine sandstone	StatoilHydro	IEA GHG R&D Programme, CSLF, European Com.
Europe, North Sea, Norway **Snovhit CO2 Storage**	700,000 tonnes CO_2 commercial 2008	2009-TBD	marine sandstone	StatoilHydro	
Europe, Germany **CO2SINK, Ketzin**	60,000 tonnes CO_2 demo 2008	2007-2010	saline sandstone	GeoForsch-ungsZentrum, Potsdam(GFZ)	CSLF, European Commission, IEA GHG R&D Prog
Australia, Victoria **Otway Basin**	100,000 tonnes CO_2 demo 2008	2005-2010	gas field sandstone	CO2CRC	CSLF
Africa, Algeria **In Salah gas**	1 Mt CO_2/yr commercial 2004	2005-2010	gas field sandstone	BP, Sonatrach, StatoilHydro	CSLF, European Commission
Asia, China, **Ordos Basin**	assessment phase CCS	2008-TBD	Ordos Basin	Shenhua Coal	

2009 American Recovery and Reinvestment Act
$3.4 Billion for FE CCS R&D



Objectives

- Demonstrate CCS technology to reduce GHG emissions from electric power and industrial applications
- Promote technology; support economic recovery; produce jobs
- All funds obligated by September 2010 and expensed by September 2015

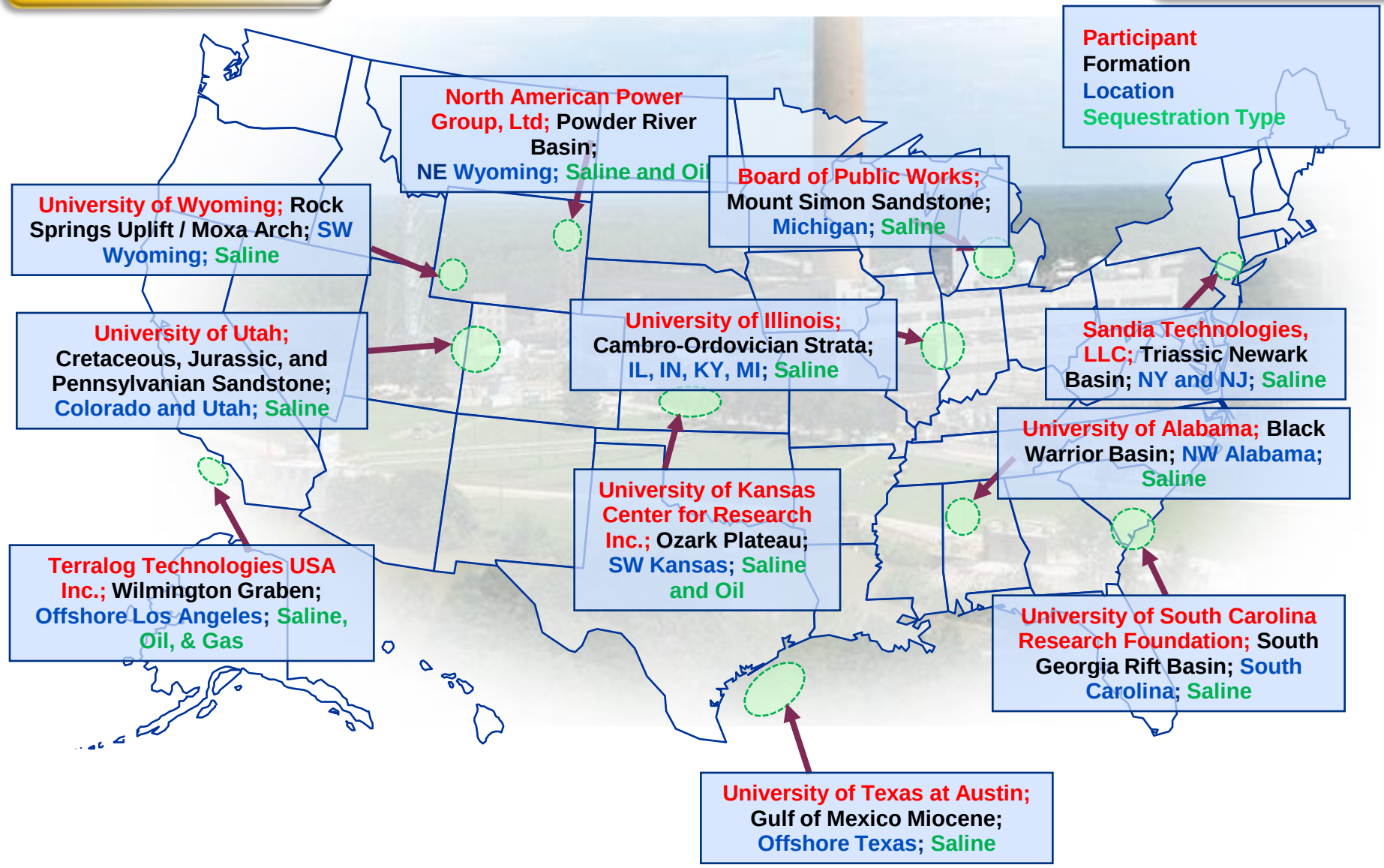
FOAs

- *Clean Coal Power Initiative – Round 3 ($800M)*
- *CCS for Industrial Sources & Innovative Concepts for Beneficial CO_2 Use ($1,500M)*
- *FutureGEN ($1,000M)*
- *Site Characterization & Promising Geologic Formations for CO_2 Storage ($80M)*
- *Geologic Sequestration Training & Research ($20M)*

Site Characterization & Promising Geologic Formations for CO_2 Storage

2009 ARRA Selected Site Characterization

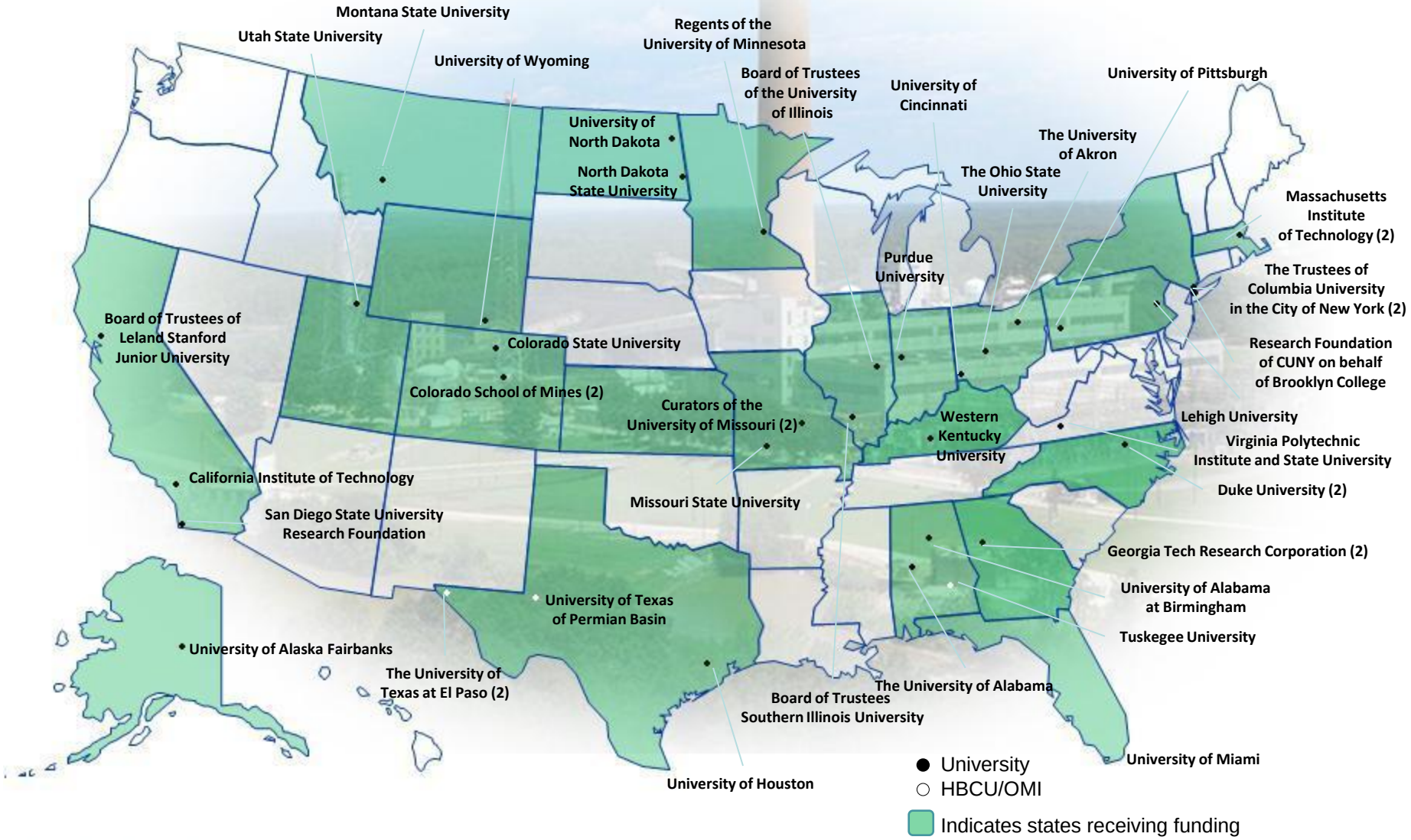
11 Selections Announced 9/16/09



Geologic Sequestration Training & Research

43 Selections Announced 9/16/09

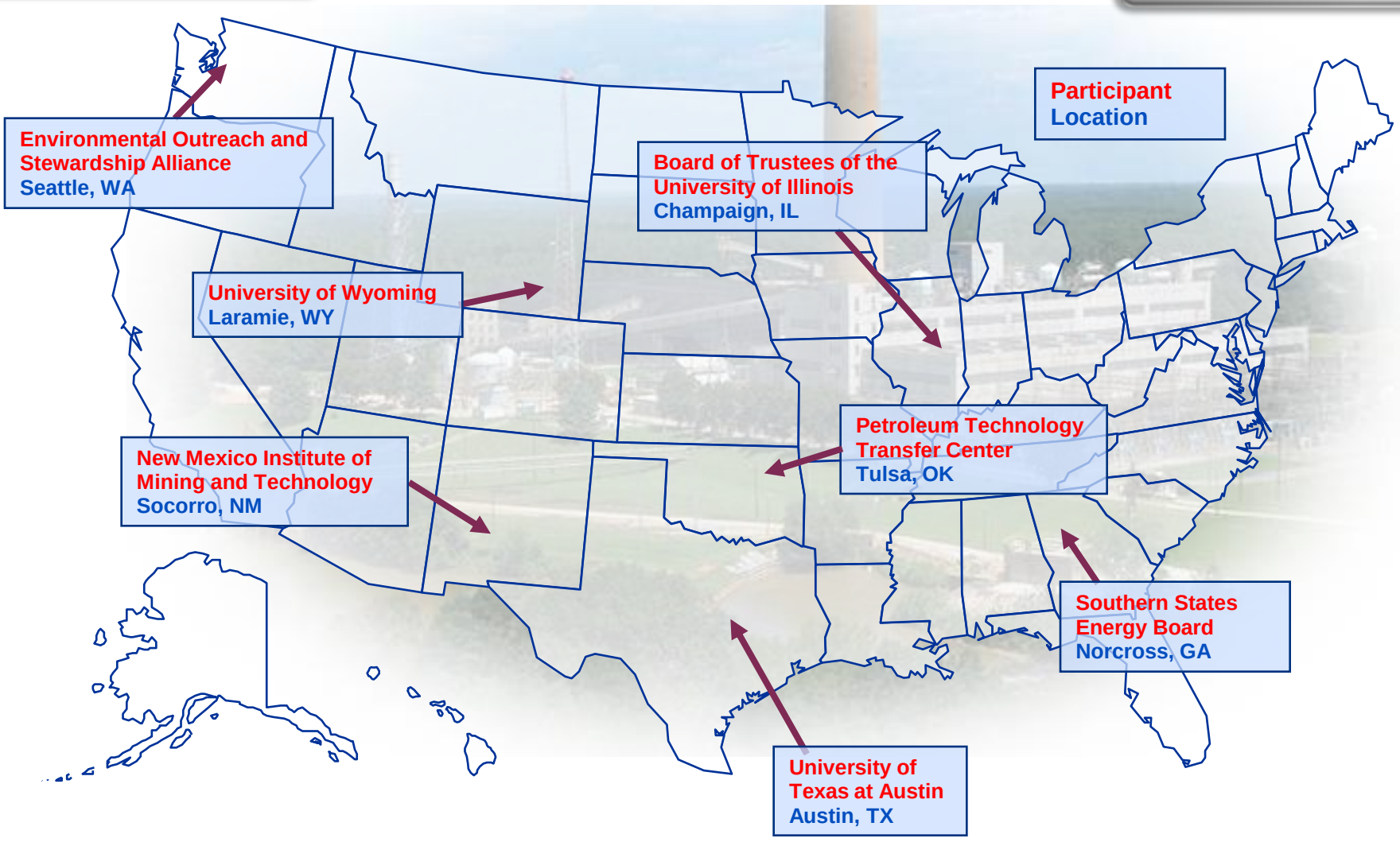
2009 ARRA
CCS *University Research and Training Grants*



Regional Sequestration Technical Training

2009 ARRA CCS Training Selections

7 Selections Announced 8/27/09



United States CCS Opportunities

- **Largest CCS RD&D program in the world**
- **Capture Technology**
  - –Intellectual Property Rights
  - –Construction at new and existing plants
- **Pipeline construction**
  - –50,000+ miles of transmission and grid lines expected by 2050
- **Geologic Field Services**
  - –Reservoir characterization
  - –Construction and operations
- **Enhanced oil recovery an early driver**
- **Human Capital necessary for CCS Industry**
  - –University and Field Service Personnel

Questions?

Additional Slides